

DYNAMICS OF EXPLODING MAGMA CHAMBERS: IMPLICATIONS FOR K/T VOLCANISM
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Although it is well known that unconfined chemical explosives may yield pressures to several megabars on detonation in air¹, the explosive literature has yet to be accessed by some contributors to the volcanological literature who've indicated that pressures in excess of the overburden and/or tensile cannot be³ obtained.² Idealized ballistic assessments of pressures internal to volcanoes³ yield pressures⁴ in the hundreds of kilobar range upon correction by addition of friction, etc.⁴ Previous assessments of exploding magma chamber pressure have been made from the characteristics of the Mt St Helens explosion. A variety⁴ of methods yield pressures of similar value: at least hundreds of kilobars.⁴ Such results are consistent with free energy requirements for quench⁴ supersaturation explosion, a process occurring in solidifying industrial melts.⁴ This process is akin to second boiling as proposed many years ago⁵ but is driven by an autocatalytic shock reaction that provides the activation energy to secure nucleation of the solid phase in undercooled melts. Solubility of volatiles drops by many orders of magnitude on passage from the liquid to solid phase. Local nucleation dumps volatiles into a high temperature environment with a concomitant local pressure spike that induces further local solidification. The portion of the melt at nucleation temperatures goes over to the solid phase as rapidly as it takes the shock to move through a melt at nucleation temperatures. Such a shock driven reaction is not constrained by slow diffusion processes in silicic melt and is by⁴ virtue of being shock driven completely analogous to⁵ detonation processes. The discovery of shocked minerals in volcanic material⁵ confirms these estimations as well as the discovery of CO₂ inclusions along shock lamellae from Vredefort minerals⁶. Several reviews of geochemical literature emphasize the carbon event at the K/T boundary as being an indicator of a massive dump of CO₂ derived from the mantle and entering the atmosphere by extensive global volcanism. Oxygen isotope data indicates extreme warming at the end of the Cretaceous which is consistent with a greenhouse effect attending the CO₂ event. Those dinosaurs surviving the iridium event at the K/T transition seem to have physiological adaptations (e.g., Triceratops frills) that facilitated control of body core temperatures, hence for awhile had capabilities^{7,8} to withstand the warming and concomitant loss of reproductive capabilities^{7,8}.

Reaction rate equations for the quench supersaturation explosion mechanism indicated above are consistent with the rise in pressure to 30kbar on solidification of magmatic melts, these pressures limited by the strength of the experimental apparatus.

References.

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